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The Role of Stent Placement in Laparoscopic Ureteroureterostomy: Experimental Porcine Model

Jonathan Picard, MD, Ronney Abaza, MD

ABSTRACT

Objective: Laparoscopic ureteral surgery is becoming increasingly common; however, advanced laparoscopic skills are required due to the precise suturing involved. Because of the size of the ureter and need for careful mucosal apposition to prevent stricturing, there is less room for error than with larger lumens, as in pyeloplasty. We sought to identify whether the presence of a stent is beneficial or a hindrance in performing ureteroureterostomy both for the novice and more experienced laparoscopist.

Materials and Methods: Eight ureteroureteral anastomoses were performed on each ureter of a 50 kg female pig for a total of 16 anastomoses. Eight were performed with a stent in place, and 8 were performed without a stent. An equal number with and without a stent were performed by a novice and an experienced laparoscopist. Anastomoses were graded by time to complete and quality of the anastomosis. Quality was graded by the presence and size of defects and patency of the lumen.

Results: The overall times required for ureteral division and spatulation, initial stitch placement, completion of the anastomosis, and total time for the stented vs. nonstented procedures were 4.3 vs. 2.2 minutes ($P=0.05$), 4.2 vs. 4.4 minutes ($P=0.16$), 10.4 vs. 13.5 ($P=0.22$) minutes, and 18.3 vs. 20.1 minutes ($P=0.49$), respectively. For stented and nonstented ureters, 3 vs. 5 anastomoses were found to have no or very small gaps, 5 vs. 1 anastomosis were found to have large gaps, and 0 vs. 2 anastomoses were found to have occluded lumens, respectively.

Conclusions: For both the novice and experienced surgeon, presence of a stent did not affect the overall time to complete a ureteroureteral anastomosis despite the significantly longer time needed to divide and spatulate the ureter. There were no occlusions when the ureteral stent was placed prior to suturing, which may indicate a reduced risk of "back-walling" the ureter.

Key Words: Laparoscopy, Ureter, Stent.

INTRODUCTION

Despite continued advancements in laparoscopic surgery allowing increasingly complicated procedures to be performed in a minimally invasive fashion, laparoscopic ureteral surgery has not received adequate attention in the literature. The majority of the literature reports regarding laparoscopic ureteroureterostomy comprise case reports and small series wherein these procedures were performed for the management of various conditions including retrocaval ureters, midureteral strictures, and iatrogenic ureteral injuries.[1–6]

Beyond these limited reports, studies specifically evaluating technical considerations are lacking. Because a suboptimal repair carries the risks of urine leakage, stricture, or even complete occlusion of the ureter, refinement and reviews of various techniques are necessary to allow better outcomes in the hands of experienced surgeons and guidance for those without experience in laparoscopic ureteral surgery.

Surgical ureteroureterostomy has traditionally been performed through an open incision appropriate for the level of the ureteral lesion in the repair of traumatic or iatrogenic injuries or after partial ureterectomy for benign disease, such as strictures. Ureteral stents are often left in place to assist with healing and urinary drainage, but when placed for this reason, the stent can be placed prior to open exposure of the ureter or after reconstruction. We sought to determine whether laparoscopic placement of a ureteral stent impacts the quality or ease of performing a ureteroureterostomy by a novice or an experienced laparoscopic surgeon.

Department of Urology, University of Toledo College of Medicine, Toledo, Ohio, USA (Dr Picard).

Robotic Urologic Surgery, Department of Urology, Ohio State University Medical Center and James Cancer Hospital, Columbus, Ohio, USA (Dr Abaza).

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Address reprint requests to: Ronney Abaza, MD, Director, Robotic Urologic Surgery, OSU Medical Center, 503 Doan Hall, 410 W. 10th Ave., Columbus, OH 43210, USA. Telephone: (614) 293-0981, Fax; (614) 293-0982, E-mail: Ronney.abaza@osumc.edu

MATERIALS AND METHODS

The research design was reviewed and approved by the animal review committee at our institution prior to beginning the protocol. Eight ureteroureteral anastomoses were performed laparoscopically on each ureter of a 50kg female pig for a total of 16 anastomoses **(Figure 1)**. Eight anastomoses were performed with a 6 French stent in place during division and spatulation of the ureter, and 8 anastomoses were performed without a stent. Half of the anastomoses with and without a stent were performed by a novice with training in intracorporeal suturing in a dry laboratory environment only (JP) and the other half by a surgeon experienced in laparoscopic ureteral and other urologic reconstruction (RA). A single 6-inch long, 4–0 vicryl suture with an RB-1 needle (Ethicon, Somerville, New Jersey) was used to complete the anastomosis in a running fashion. Stented and nonstented anastomoses were performed in an alternating manner extending between the proximal and distal ureter.

The times required for ureteral division and spatulation, initial stitch placement, and completion of the anastomosis were recorded. At the conclusion of the surgical procedure, the pig was euthanized and the ureters were removed for analysis. The quality of the anastomosis was determined based on the presence of gaps between any of the sutures in the anastomosis as well as the size of the defects and the patency of the lumen. The ureters were also perfused with saline at a pressure of 30cm H_2O to evaluate the size of defects and patency. The absence of defects was noted as "none," while small and large defects were quantified as 1mm to 2mm and >2mm in length, respectively.

Figure 1. Laparoscopic port placement for sutured ureteroureterostomy.

A 2-sided, paired Student *t* test was used in analysis of the data with significance defined as a P-value of less than or equal to 0.05.

RESULTS

The mean time in minutes required for completion of the ureteral division and spatulation, initial stitch placement, completion of the anastomosis, and total time for the stented and nonstented procedures was 4.3 vs. 2.2, 4.2 vs. 4.4, 10.4 vs. 13.5, and 18.3 vs. 20.1 minutes, respectively. In reviewing the performance of the novice and experienced surgeons independently, the time in minutes required for completion of the ureteral division and spatulation, initial stitch placement, completion of the anastomosis, and total procedure time for the stented versus the nonstented procedures was 4.4 vs. 2.3, 3.2 vs. 4.5, 13.1 vs. 16.4, and 20.7 vs. 23.2 minutes, respectively, for the novice laparoscopist and 4.2 vs. 2.2, 5.3 vs. 4.2, 7.6 vs. 10.6, and 16.0 vs. 17.0 minutes for the more experienced laparoscopist **(Table 1)**.

In the stented and nonstented ureters, 3 vs. 5 anastomoses were found to have no or small gaps, 5 vs. 1 anastomosis were found to have large gaps, and 0 vs. 2 anastomoses were found to have occluded lumens, respectively **(Table 2)**.

DISCUSSION

The feasibility of laparoscopic ureteroureterostomy has been demonstrated by multiple authors in the management of obstruction secondary to retrocaval ureters or ureteral strictures with varying techniques of stent usage. Retrocaval ureteral reconstruction has been described by 2 groups both using an open-ended ureteral catheter placed preoperatively followed by division of the ureter, repositioning of the proximal and distal ureter anterior to the vena cava, and advancement of the ureteral catheter into the renal pelvis until replacement by a double-J ureteral stent after completion of the anastomosis.[1,2] Bhandarkar et al[3] repaired a congenital midureteral stricture laparoscopically using a double-J stent advanced to the level of the stricture until resection and reconstruction with the stent then advanced to the renal pelvis.

There is still a paucity of data in the literature regarding outcomes after laparoscopic ureteroureterostomy. Nezhat et al[4] reported follow-up of 2 months to 6 years on 9 patients who had undergone either a laparoscopic ureteroureterostomy (8 procedures) or laparoscopic uretero-

Table 1.
Mean Operative Times for Various Individual Steps of Laparoscopic Ureteroureterostomy Procedure and Total Time

	Ureteral Division			Initial Stitch			Anastomosis			Total Time		
	Stent	No Stent	P value	Stent	No Stent	P value	Stent	No Stent	P Value	Stent	No Stent	P Value
Novice	4.4	2.3	0.07	3.2	4.5	0.11	13.1	16.4	0.34	20.7	23.2	0.41
Experienced	4.2	2.2	0.42	5.3	4.2	0.68	7.6	10.6	0.13	16.0	17.0	0.82
Overall	4.3	2.2	0.05	4.2	4.4	0.16	10.4	13.5	0.22	18.3	20.1	0.49

Table 2.
Anastomotic Defects and Degree in Laparoscopic Ureteroureterostomy Performed With and Without a Stent

	Stent	No Stent
Small (1–2 mm)	3	5
Large (>2 mm)	5	1
Obstructed	0	2

neocystostomy (2 procedures) after iatrogenic injuries. Seven patients had successful outcomes, while one patient required transvesical ureteral dilatation and another developed a recurrent ureteral stricture distal to the anastomotic site requiring laparoscopic ureteroneocystostomy. Simmons et al[5] described their series of 46 ureteral procedures for benign ureteral stricture disease including open and laparoscopic ureteroureterostomy as well as other procedures. Thirty-one patients underwent 34 open procedures (including 9 ureteroureterostomies), and 12 patients underwent 12 laparoscopic procedures (including 5 ureteroureterostomies) with 6-French, double-J stents placed in all cases. With a median follow-up of 34 months for the open group (range, 11 to 79) and 23 months (range, 4 to 70) for the laparoscopic group, respectively, success rates and complications were not different between the 2 groups.

A review of the thus-far limited literature supports not only the feasibility of laparoscopic ureteroureterostomy but also suggests successful outcomes similar to those with standard open repair. Widespread adoption of laparoscopic reconstruction by the urologic community will require that surgeons learn the complex skills required and that more experienced surgeons learn how to teach these techniques to those in training. As with all procedures, technique varies among surgeons and most notably among surgeons of different levels of experience. Our goal was to determine whether an indwelling stent or ureteral catheter facilitates or hinders the performance of laparoscopic ureteroureterostomy and whether this depends on the experience of the laparoscopist.

In our experimental model, the mean time required for ureteral division and spatulation was significantly less for the unstented ureter, as might be expected given that the stent seemed to interfere with cutting of the ureter while trying not to cut the stent. In regards to times for initial stitch placement, completion of the anastomosis, and total time for the stented and nonstented procedures, though, there was no statistical difference. In reviewing the performance of the novice and experienced surgeons independently, the mean time required for anastomoses was not significantly different for either one. The data did suggest a trend towards faster anastomoses with a stent, but statistical significance may have been hindered by sample size. This finding, regardless of the surgeon's laparoscopic experience, may be due to an increased ability to identify the ureteral lumen during completion of the anastomosis **(Figure 2)**.

Anastomotic quality was impacted by the presence of a ureteral stent, whereby in the stented group, gaps between any of the sutures in the stented anastomoses were slightly more common overall at 8 versus 6, but no stented anastomoses were found to have occluded lumens compared with lumens in 2 of the nonstented group. There was a trend toward tighter anastomoses when a stent was not present in the ureter, which is advantageous, but with 2 occluded anastomoses the expected outcome in a human patient would likely be reoperation or loss of the renal unit. We attribute the absence of occlusion with a stent present to an increased ability to identify the ureteral lumen and thereby minimize the risk of "back-walling" any of the stitches.

A larger cohort of laparoscopists and more total anastomoses may have better represented the differences between performing an anastomosis with and without a stent in place. Additionally, although a 50kg porcine model is a decent representation of the human genitourinary tract, the kidneys and ureters are smaller than typi-

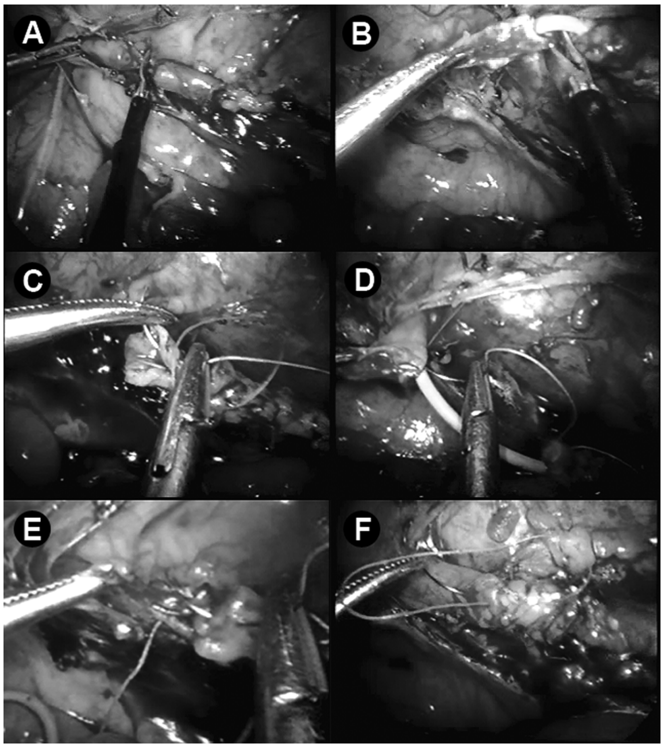

Figure 2. Laparoscopic ureteral division without stent (A) versus with stent (B) where navigation around stent is necessary, first ureteral anastomotic stitch without stent (C) versus with stent (D) where needle must be passed alongside stent but where "back-walling" is not possible, and final anastomotic suture without stent (E) versus with stent (F) where stent may aid with identification of lumen.

cally found in the adult human, and we only tested the most commonly used caliber of ureteral stent in our study. Additionally, the port placement in this experiment was centered at the level of the mid to proximal ureter, which increased the level of difficulty when performing ureteroureterostomy on the distal ureter. Nevertheless, we believe that the findings of at least as good of an operative time for anastomoses and lower likelihood of occlusion with a stent would hold true for a procedure on a human ureter.

In this study, a ureteral stent was either placed prior to ureteral division and suturing of the anastomosis or was not placed at any point during the ureteral division and suturing of the anastomosis. Alternatives to this in a true operation might include ureteral division and spatulation without a stent followed by stent placement and suturing with it in position or ureteral division with spatulation and suturing of a portion of the anastomosis without a stent followed by stent placement and completion. This last approach, which has become our method of choice **(Figure 3)**, may indeed take advantage of the ease of ureteral division with spatulation without a ureteral stent and retain the advantage of improved visualization of the ureteral lumen and minimization of the risk of "back-walling." Based on our findings and personal, subjective conclusions from this experiment, we would recommend having a stent in place particularly during the final stitches of the anastomosis regardless of when the stent is placed so as to prevent occlusion at this point when the lumen is difficult to identify. With the advent of robotic ureteral surgery, further study will be necessary to identify whether similar or unique benefits or limitations of stenting exist in the setting of laparoscopy with robotic instrumentation.[7–9]

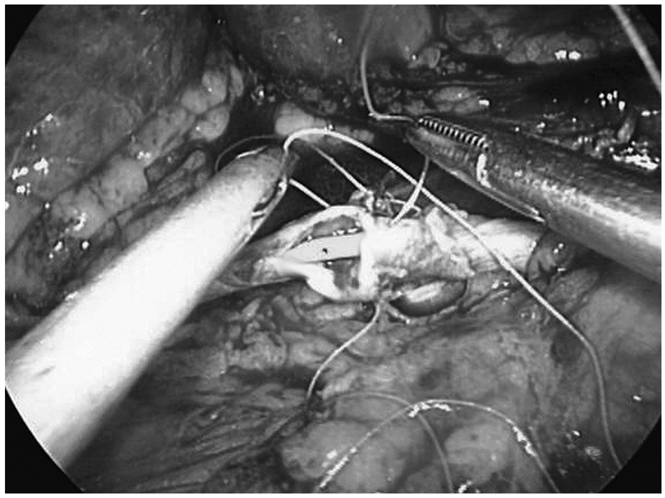

Figure 3. Laparoscopic ureteroureterostomy after iatrogenic injury during laparoscopic partial colectomy with stent placed after anastomosis partially completed.

CONCLUSIONS

Although more time was needed for division and spatulation of the ureter, the presence of a ureteral stent did not affect the overall time for completing laparoscopic ureteroureteral anastomoses, despite a trend towards shorter procedure times with the stent in place. These results were common to both the novice and experienced laparoscopic surgeons. Additionally, there were no instances of ureteral occlusion with a ureteral stent in place during suturing. This may represent a reduced risk of "back-walling" the ureter during suture placement. Preoperative ureteral stent placement when performing laparoscopic ureteroureterostomy may be advantageous both for the experienced laparoscopist and the novice, but further refinement and investigation in technique are necessary to optimize results in human patients.

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